ADVANCED LIFE SCIENCE: PLANTS AND SOILS (L) STANDARDS

Students study concepts, principles, and theories associated with plants and soils. Knowledge gained enables them to better understand the workings of agricultural and horticultural practices. They recognize how plants are classified, grow, function, and reproduce. Students explore plant genetics and the use of plants by humans. They examine plant evolution and the role of plants in ecology. Students investigate, through laboratories and fieldwork, how plants function and how soil influences plant life.

Standard 1
Taxonomy and Classification

Students know that organisms are classified, concentrating on a general survey of all living things, then specifically how certain characteristics categorize plants in a taxonomic key.

PS.1.1 Explain the classification of organisms based on a hierarchical taxonomy including kingdom, division, class, order, family, genus, and species.

PS.1.2 Distinguish the five kingdoms of organisms, and more specific taxonomy of agricultural species of plants.

PS.1.3 Define varieties and cultivars.

PS.1.4 Identify plants using a taxonomic key.

Standard 2
Molecules and Plant Cells

Background in basic cellular chemistry aides students knowing some of the similarities of all cells and the unique features of plants, and their specialized functions. It is also known that certain chemicals, such as auxins, acids, hormones, gases, and polymers play an important role in plant development.

PS.2.1 Compare and contrast molecules.

PS.2.2 List and Describe the four major organic macromolecules (carbohydrates, lipids, proteins, and nucleic acids) found in all living organisms.

PS.2.3 Explain the concepts of monomers and polymers, and recognize the monomer and polymer for each class of macromolecule. In addition, describe the function of condensation and hydrolysis in the construction and breakdown of polymers.

PS.2.4 Compare and contrast three types of chemical bonds: hydrogen, ionic and covalent bonds.

PS.2.5 Compare and contrast single and double bonds.

PS.2.6 Predict the number and type of bonds an atom will form based on its valence electrons.

PS.2.7 Identify functional groups such as hydroxyl, amino and carboxyl.

PS.2.8 Predict what kinds of molecules dissolve in water and which do not. Define solute, solvent, and saturation.

PS.2.9 Compare and contrast animal, plant and bacterial cells. Describe the similarities between photosynthetic bacteria and chloroplasts. Explain that some structures in the modern eukaryotic cell developed from early prokaryotes, such as mitochondria, and in plants, chloroplasts.

PS.2.10 Contrast the biochemistry and functions of plant cell membranes and cell walls. Describe the structural roles of cellulose and other compounds in the primary and secondary walls, the role of pectin in the middle lamella, the fluid mosaic model of the membrane, and the role of the cell membrane proteins in transporting materials in and out of cells.

PS.2.11 Explain the roles of the vacuole and cell wall in controlling cell turgor. Describe the phenomena of osmosis and turgor pressure, predict the direction that water will move given the concentrations of solutes in adjacent cells, and demonstrate the proper use of terms associated with turgor such as turgid, flaccid, hypertonic and hypotonic.

PS. 2.12 Describe the genomes in a plant cell's nucleus, plastids and mitochondria.

PS.2.13 Compare and contrast photosynthesis and respiration. Recognize that animals perform only respiration, while plants perform both photosynthesis and respiration. In addition, identify the plant organelles that perform each process, contrast the equations of the two processes, using both words and chemical formulae, contrast the source of energy for each process, describe the role of ATP in each process, and describe how hydrogen ion gradients are produced and can be used as an energy source in many cellular processes.

PS.2.14 Compare and contrast hydrophilic vs. hydrophobic and polar vs. non-polar molecules.

Standard 3

Development and Function of Plant Systems

Students are aware that plants have a variety of cells and tissues with specific functions and systems, and that those processes may even be different in different species. Certain specific chemicals are catalysts to promote a specific process within plants.

PS.3.1 Describe and give functions for common plant cell types, including meristematic cells, epidermal cells, photosynthetic cells, xylem vessel elements, sieve tube elements, companion cells, cork cells and fibers.

PS.3.2 Compare multi-cellular systems and single cell systems.

PS.3.3 Identify cell types and functions associated with the vascular, dermal and ground tissue systems in woody and herbaceous plant parts. In doing so, compare and contrast periderm and epidermis and xylem and phloem. Also, describe the role of cell death in the differentiation of xylem, and contrast the relative volumes of xylem, phloem and ground tissue in woody vs. herbaceous tissues.

PS.3.4 Describe the role of the shoot apical meristem in stem elongation and leaf production, the role of the root apical meristem in root elongation and root cap maintenance, and the roles of the vascular and cork cambia in wood and bark production.

PS.3.5 Identify and explain the functions of leaf cells and tissues, including epidermis, guard cells, mesophyll, xylem and phloem. Describe the chemical composition of the cuticle, and explain how it helps plants conserve water. Explain the role of the guard cells in opening and closing stomata, and the roles of the stomata in photosynthesis and transpiration. Explain how the carbon dioxide and water needed for photosynthesis reach the mesophyll, and how sugar is exported from the mesophyll.

PS.3.6 Explain how water and minerals move through the xylem and organic compounds move through the phloem.

PS.3.7 Describe the roles of root parts including the root cap, the root apical meristem, root hairs, cortex, xylem and phloem. Explain how osmosis and root pressure contribute to water uptake and transport, and explain the role of active transport in mineral uptake.

PS.3.8 Describe the process of sexual reproduction in flowering plants. Explain the variety of ways flowers are pollinated, including wind and different types of

pollinators. Describe how pollen tubes grow from the stigma to ovules, the process of double fertilization, and the roles of the endosperm and zygote resulting from this process. Describe the roles of the various flower organs, including the relationships between ovule and seed, and ovary and fruit. In addition, compare and contrast the structures, chemical compositions and uses of different seeds, including examples of grains and legumes

PS.3.9 Give examples of asexual reproduction in plants. Include some natural ways that plants reproduce asexually, and describe methods of asexual reproduction used by growers. Discuss the roles of natural and synthetic hormones in plant propagation.

PS.3.10 Describe the ripening of a fleshy fruit and the role of ethylene in ripening. Describe how ethylene is important in harvest and post-harvest in many fruits.

PS.3.11 Explain the contribution of abscisic acid and dehydration to seed dormancy. Describe some methods of breaking seed dormancy, and explain under what circumstances each is an advantage for the plant.

PS.3.12 Describe how the interaction of auxin and cytokinin control development of lateral buds into branches. Explain why pruning that removes the apical meristem of a stem stimulates branch production.

PS.3.13 Identify the macro and micro nutrients essential for plant growth and describe some of their functions in plants.

Standard 4

Plant Genetics – Chemistry and Expression

Students know the roles of t-RNA, m-RNA, and DNA, other chemistry of genes and genomes, and a plant's environment in reproduction and expression.

PS.4.1 Describe how the interaction between the genotype and the environment produces a phenotype. Explain the flow of information from gene to protein. Discuss the production and roles of messenger RNA, transfer RNA and ribosomes during protein synthesis. Explain how alterations in a plant's chemical or physical environment can change whether or not a gene is turned on, and thus whether a phenotype is expressed.

PS.4.2 Define the term genome. Explain the function of coding regions and non-coding regions within the genome.

PS.4.3 Explain how differential gene expression is what determines which proteins are made, and how the proteins decide the characteristics and functions of a particular cell.

PS.4.4 Using examples relevant to plant science, track the events involved in expression of individual genes and compartmentalization of the resulting proteins.

PS.4.5 Describe a situation in which a plant characteristic is controlled by many genes.

PS.4.6 Describe the relationship between DNA replication, mitosis and meiosis.

PS.4.7 Explain that DNA replication and gene expression are independent phenomena.

Standard 5

Evolutionary Trends and Ecology

Students know that there are a variety of factors that contribute to the development and survival of plant species. Success of survival may depend upon breeding programs, environmental factors, and genes. Students also know that specific cycles, minerals, and other organisms may affect the success and survival of plants (as a species, crop, or as an individual). Some plants have ways of protection or defense.

PS.5.1 Explain the significance of genetic diversity to evolution. Explain how both meiosis and fertilization contribute to diversity within a gene pool. Describe how outcrossing promotes diversity, and ways that plants prevent self-pollination and/or promote cross-pollination. Discuss how genetic diversity is preserved among both crops and wild plants. List the assumptions of the Hardy-Weinberg Principle. Explain the disadvantages of lack of diversity in the wild and monoculture in the field.

PS.5.2 Compare and contrast natural selection with artificial selection, as used by humans to domesticate plants and breed improved varieties. Describe some of the traits that have been selected in the domestication of plants. Contrast the rates at which gene frequencies change during natural selection, artificial selection involving traditional breeding, and breeding programs involving biotechnology.

PS.5.3 Compare and contrast adaptations of plants for survival and seed dispersal in different environmental conditions.

PS.5.4 Explain how climate is a factor in the selection of both crop and ornamental plants.

PS.5.5 Define hybridization, and describe how it can lead to the development of unique species and varieties.

PS.5.6 Describe methods of producing transgenic plants and ways in which they are used. Describe some of the risks of conventional and biotech plant breeding. Explain that the risks and benefits of introducing a gene depend on the identity of the gene rather than the mechanism by which it is introduced. Discuss the risks and benefits of several genes that have been introduced into plants by genetic engineering.

PS.5.7 Explain the roles of plants in the global carbon cycle, including their impact on atmospheric carbon dioxide and their roles in food webs.

PS.5.8 Describe the nitrogen and phosphorus cycles, including the roles of plants, bacteria and fungi. Identify the reactants and products of nitrogen fixation. Contrast symbiotic and free-living nitrogen fixing bacteria, and explain how mycorrhizae impact plant nutrition. Describe the advantages and disadvantages of nitrate, ammonium and organic nitrogen in fertilizers

PS.5.9 Discuss the impact of nutrient runoff on various nutrient cycles.

PS.5.10 Describe plant interactions with mutualistic, commensalistic, parasitic and predatory organisms.

PS.5.11 Describe various approaches to control plant and animal pests. Explain how pest management systems, such as integrated pest management programs, can minimize damage to non-target species, and explain how applied chemicals can be used to control pest populations.

PS.5.12 Explain how plants sense changes in their environment and respond. Explain how photoperiod and thermoperiod impacts flowering and other seasonal events. Explain how plants alter their direction of growth through various tropisms.

PS.5.13 Describe some of the ways in which plants defend themselves against pathogens and insects.

Standard 6

Physical Environment: Soils – Formation and Chemistry

Students know different soil types and how they are formed, determined, and how they compare to each other. Organic, inorganic and other chemical components are important in soil types and can affect acidity and mineral content. These factors are also crucial for plant survival or decline.

PS.6.1 Define water holding capacity and describe its role in the availability of water to the plant.

PS.6.2 Describe how decomposers affect organic material formation.

PS.6.3 Describe the inverse relationship between drainage and oxygen availability.

PS.6.4 Compare and contrast ion exchange capacity in natural soils and artificial media.

PS.6.5 Define anion and cation, and describe their roles in soil science.

PS.6.6 Describe the physical and chemical structures and functions of soil components including sand, silt, clay, and organic matter.

PS.6.7 Compare the chemical properties of various clays and explain the role of each in soil structure.

PS.6.8 Identify and describe the various soil horizons and their roles.

PS.6.9 Explain the physical, chemical, geological and biological processes of soil formation.

PS.6.10 Discuss the effects of soil pH on mineral availability and toxicity. Describe the chemical reactions by which lime and sulfur impact soil pH.